Line identification in IPv6 Router Solicitation messages
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Abstract

In Ethernet and GPON based aggregation networks, several subscriber premises may be logically connected to the same interface of an edge router. This document proposes a method for the edge router to identify the subscriber premises using the contents of the received Router Solicitation messages. The applicability is limited to the N:1 VLAN allocation model.

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1. Introduction

DSL is a widely deployed access technology for Broadband Access for Next Generation Networks. While traditionally DSL access networks were PPP based some networks are migrating from the traditional PPP access model into a pure IP-based Ethernet aggregated access environment. Architectural and topological models of an Ethernet aggregation network in context of DSL aggregation are described in [TR101].

![Network Architecture Diagram]

Figure 1: Broadband Forum Network Architecture

One of the Ethernet and GPON aggregation models specified in this document bridges sessions from multiple user ports behind a DSL Access Node (AN), also referred to as a DSLAM, into a single VLAN in the aggregation network. This is called the N:1 VLAN allocation model.
1.1. Terminology

**1:1 VLAN**

It is a broadband network deployment scenario where each user port is mapped to a different VLAN on the Edge Router. The uniqueness of the mapping is maintained in the Access Node and across the Aggregation Network.

**N:1 VLAN**

It is a broadband network deployment scenario where multiple user ports are mapped to the same VLAN on the Edge Router. The user ports may be located in the same or different Access Nodes.

**AN**

A DSL or GPON Access Node. The Access Node terminates the physical layer (e.g. DSL termination function or GPON termination function), may physically aggregate other nodes implementing such functionality, or may perform both functions at the same time. This node contains at least one standard Ethernet interface that serves as its "northbound" interface into which it aggregates traffic from several user ports or Ethernet-based "southbound" interfaces. It does not implement an IPv6 stack but...
performs some limited inspection of IPv6 packets.

**Aggregation Network**
The part of the network stretching from the Access Nodes to the Edge Router. In the context of this document the aggregation network is considered to be Ethernet based, providing standard Ethernet interfaces at the edges, for connecting the Access Nodes and Broadband Network. It is comprised of ethernet switches that provide very limited IP functionality (e.g. IGMP snooping, MLD snooping etc.).

**Edge Router**
The Edge Router, also known as the Broadband Network Gateway (BNG) is the first IPv6 hop for the user. In the cases where the RG is bridged, the BNG acts as the default router for the hosts behind the RG. In cases where the RG is routed, the BNG acts as the default router for the RG itself. This node implements IPv6 router functionality.

**GPON**
Gigabit-capable Passive Optical Network is an optical access network that has been introduced into the Broadband Forum architecture in [TR156]

**Host**
A node that implements IPv6 host functionality.

**RG**
A residential gateway device. It can be a Layer 3 (routed) device similar to one specified in or a Layer 2 (bridged) device. The residential gateway for Broadband Forum networks is defined in [TR124]

**End-device**
A node that sends Router Solicitations and processes received Router Advertisements. When a Layer 3 RG is used it is considered an end-device in the context of this document. When a Layer 2 RG is used, the host behind the RG is considered to be an end-device in the context of this document.

### 1.2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].
2. Issues with identifying the subscriber in an N:1 VLAN model

In a DSL or GPON based fixed Broadband Network, IPv6 end-devices are connected to an Access Node (AN). These end-devices today will typically send a Router Solicitation Message to the Edge Router, to which the Edge Router responds with a Router Advertisement message. The Router Advertisement typically contains a prefix that the end-devices will use to automatically configure an IPv6 Address. Upon sending the Router Solicitation message the node connecting the end-device on the access circuit, typically an Access Node (AN), would forward the RS to the Edge Router upstream over a switched network. However, in such Ethernet-based aggregation networks, several subscriber premises may be connected to the same interface of an edge router (e.g. on the same VLAN). However, the edge router requires some information to identify the end-device on the circuit line the end-device is connected on. To accomplish this, the AN needs to add line identification information to the Router Solicitation message and forward this to the Edge Router. This is analogous to the case where DHCP is being used, and the line identification information is inserted by a DHCP relay agent. This document proposes a method for the edge router to identify the subscriber premises using the contents of the received Router Solicitation messages.

3. Applicability

The line identification option is intended to be used only for the N:1 VLAN deployment model. For the other VLAN deployment models there is no need to carry line identification.

4. Basic operation

This document recommends tunneling Neighbor discovery packets inside another IPv6 packet that uses a destination option to convey line identification information. The Neighbor discovery packets initiated by the end-device are left unmodified inside the encapsulating IPv6 packet. In particular, the Hop Limit field of the ND message is not decremented when the packet is being tunneled. This is because ND messages whose Hop Limit is not 255 will be discarded by the receiver of such messages.

5. Access Node Behavior
5.1. On receiving a Router Solicitation from the end-device

When an end-device sends out a Router Solicitation, it is received by the access node. The AN then tunnels the received Router Solicitation in a newly created IPv6 datagram with the Link Identification Option (LIO). The AN forms a new IPv6 datagram whose payload is the received Router Solicitation message as described in [RFC2473] except that the Hop Limit field of the Router Solicitation message MUST NOT be decremented. If the AN has an IPv6 address, it SHOULD use this address in the Source Address field of the outer IPv6 datagram. Otherwise it MUST use the unspecified address as the Source Address of the outer IPv6 datagram. The destination address of the outer IPv6 datagram MUST be copied from the destination address of the tunneled RS. The AN MUST insert a destination options header between the outer IPv6 header and the payload. It MUST insert a LIO destination option and set the line identification field of the option to contain the circuit identifier corresponding to the logical access loop port of the Access Node from which the RS was initiated. It MUST also insert the hardware address of the client (from the source hardware address of the RS) into the client hardware address field of the option.

5.2. On receiving a Router Advertisement from the Edge Router

Since the Router Advertisements are unicasted by the edge router towards the end-devices the access node does not need to intercept the downstream Router Advertisements.

6. Edge Router Behavior

6.1. On receiving a Router Solicitation from the Access Node

When the edge router receives a tunneled Router Solicitation forwarded by the access node, it needs to check if there is an LIO destination option present in the outer datagram. If an LIO option is present, the edge router MUST verify that the Option Length field of this option is set to ClientHWALen+LineIDLen+2. If not the edge router MUST discard the tunneled Router Solicitation. The edge router can use the contents of the line identification field to lookup the addressing information and policy that need to be applied to the line from which the Router Solicitation was received. The edge router MUST then process the inner RS message as specified in [RFC4861]
6.2. On sending a Router Advertisement towards the end-device

When the edge router sends out a Router Advertisement in response to a tunneled RS that included an LIO option, it MUST unicast the RA at layer 2 back to the sender of the RS. If the source address of the RS was the unspecified address, then the IPv6 destination address of the RA MUST be set to the all-nodes multicast address, otherwise the IPv6 destination address is copied from the inner IPv6 source address of the Router Solicitation. In both cases the link-layer destination address MUST be set to the unicast link-layer address which is in Client Hardware Address field in the LIO.

7. Line Identification Option

The Line Identification Option (LIO) is a destination option that can be included in IPv6 datagrams that tunnel Router Solicitation and Router Advertisement messages. Multiple Line Identification options MUST NOT be present in the same IPv6 datagram. The LIO has an alignment requirement of (none).

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Option Type | Option Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| LineIDLen   | Line Identification... |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| ClientHWALen | Client Hardware Address... |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: Line Identification Option Layout
Option Type

8-bit identifier of the type of option. The option identifier for the line identification option will be allocated by the IANA.

Option Length

8-bit unsigned integer. The length of the option (excluding the Option Type and Option Length fields). The value 0 is considered invalid.

LineIDLen

Length of the Line Identification field in number of octets.

Line Identification

Variable length data inserted by the Access Node describing the subscriber agent circuit identifier corresponding to the logical access loop port of the Access Node from which the RS was initiated.

ClientHWALen

Length of the Client Hardware Address in number of octets.

Client Hardware Address

Variable length client hardware address as detected by the access node.

8. Interactions with Secure Neighbor Discovery

Since the SEND [RFC3971] protected RS/RA packets are not modified in anyway by the mechanism described in this document, there are no issues with SEND verification.

9. Acknowledgements

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10. Security Considerations

The line identification information inserted by the access node or the edge router is not protected. This means that this option may be modified, inserted, or deleted without being detected. In order to ensure validity of the contents of the line identification field, the network between the access node and the edge router needs to be trusted.

11. IANA Considerations

This document defines a new IPv6 destination option for carrying line identification. IANA is requested to assign a new destination option type in the Destination Options registry maintained at

http://www.iana.org/assignments/ipv6-parameters

<TBA> Line Identification Option [RFCXXXX]

The act bits for this option need to be 10 and the chg bit needs to be 0.

12. Normative References


[TR156] Broadband Forum, "Using GPON Access in the context of TR-

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